

# Change in the quality of atmospheric air under the influence of chemical enterprises in the Sverdlovsk Region cities

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**Abstract.** In this article, we investigated the gaseous emission dynamics of Sverdlovsk region chemical complex from 2011 to 2015. We have analyzed the dynamics of changes in the atmospheric air state in cities where the big chemical enterprises are located. Our main attention is paid to gases emissions such as carbon monoxide, nitrogen oxides and sulfur dioxide. We also looked at the volume of purified gas emissions in all gaseous emissions from the chemical industry enterprises. The contribution of emissions from chemical industry is relatively low and accounts for approximately 4 % of emissions from all manufacturing industries, including metallurgical complexes. There is a general tendency to reduce emissions of pollutants in connection with the implementation of environmental measures. Reducing the gaseous substances emission can be achieved both by improving the production technology, and by installing new more sophisticated equipment which catches harmful substances emissions.

## 1. Introduction

At the beginning of the 20<sup>th</sup> century man's anthropogenic influence was not as high as at the beginning of the 21<sup>st</sup> century. During one hundred years the economic activity of man has so strongly influenced on the state of the environment that it can lead to irreversible changes of the future destiny of humankind. Excessive emissions into the atmosphere, dumping into the hydrosphere, solid waste disposal in the lithosphere are resulted in such negative consequences as: greenhouse effect, smog, acid rains, significant excess of TLV (threshold limit value) of many dangerous substances in places of people's lives, etc. At the present, human society is trying to solve environmental problems that have created for ourselves, in order to live and not survive on the Earth [1–3].

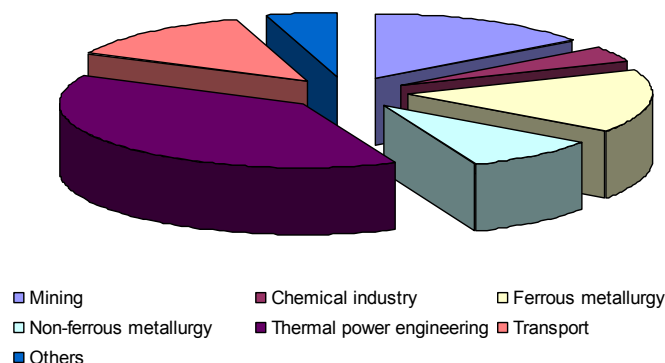
## 2. Methods

One of the main and acute problems of humankind is the air pollution with gaseous emissions. The largest emissions into the air environment are emissions of SO<sub>2</sub>, CO, NO<sub>x</sub> and solids (dust) [4–6]. They have a detrimental effect on the health of animals and humans. Sulfur oxide (IV) causes a runny nose, cough, hoarseness, and swelling in the throat. Large concentrations of SO<sub>2</sub> lead to suffocation, speech disorders, difficulty swallowing, vomiting, and possible acute edema of the lungs. Carbon oxide (II) prevents oxygen absorption by blood hemoglobin, which weakens cognitive abilities, slows down reflexes, causes drowsiness and can cause loss of consciousness and death. Nitrogen oxides cause a weakening of smell, reduce the ability of the eye to adapt to darkness, increase the effort expended on breathing, make a person more susceptible to diseases of the respiratory system. Dust



leads to irreversible changes in lung tissue. In the zones of intense dust pollution, a number of specific diseases arises, for example, silicosis and asbestosis [7–9].

Undoubtedly, the main industrial sources of harmful emissions are thermal power, ferrous and non-ferrous metallurgy. However, the contribution of the chemical and oil refining industry is also high (Figure 1).



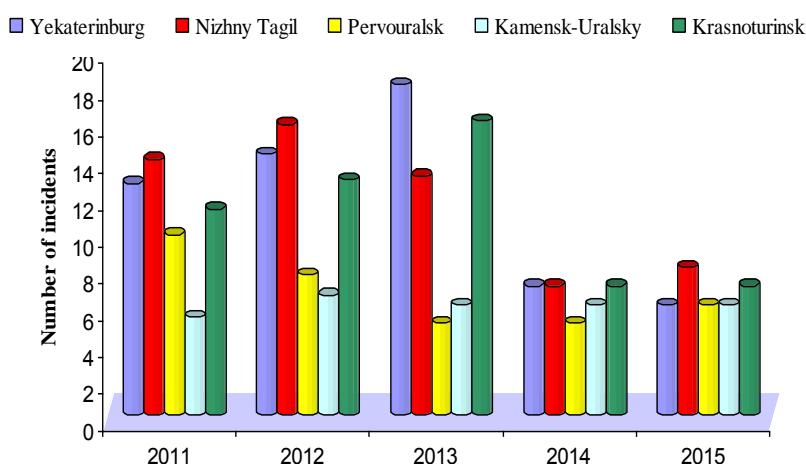
**Figure 1.** The main emission sources into the atmosphere

### 3. Results and discussion

#### 3.1. The atmospheric air quality

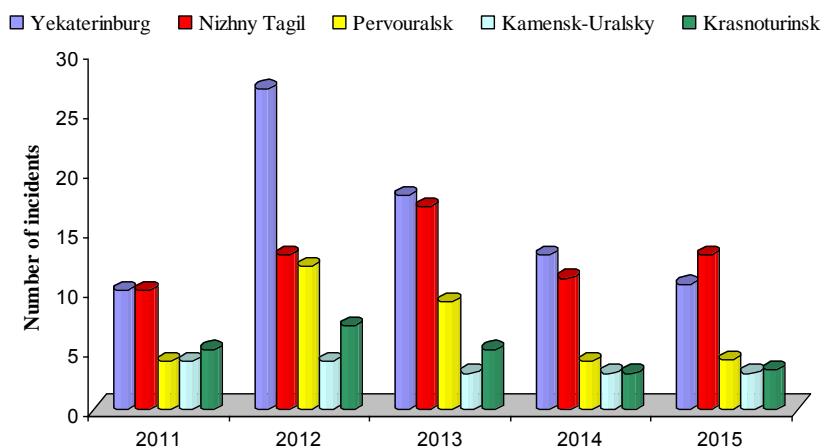
The state observation organizations carry out data acquisition on environmental pollution during the monitoring of pollutions [10, 11]. We have analyzed the data of state reports on air pollution in those Sverdlovsk region cities where chemical enterprises are located.

We found that for the period from 2011–2015 the number of cities with a very high level of atmospheric pollution has not changed (the high level of atmospheric pollution is remained at the same level in Nizhny Tagil and Krasnoturinsk). In Pervouralsk and Kamensk-Uralsky, the high level of pollution has decreased to an increased level. However, in 2015 the pollution level rose to a high level in Kamensk-Uralsky. The pollution level in Yekaterinburg is remained at the same level namely high during the past 2 years (Figure 2) [12, 13].



**Figure 2.** The atmospheric air quality in the Sverdlovsk region cities based on the values of the complex index (IPA) of atmospheric pollution in 2011–2015  
 0–4 – low level of pollution                      5–6 – increased level of pollution  
 7–13 – high level of pollution                      14 and above – very high level of pollution

In 2015, the values of the standard index (SI) which characterize the maximum value of the concentration in fractions of the corresponding TLV were very high in Yekaterinburg and Nizhny Tagil and were determined by the maximum daily average concentrations of ethylbenzene in Ekaterinburg and the maximum average monthly concentrations of benzopyrene in Nizhny Tagil (Figure 3).



**Figure 3.** The atmospheric air quality in the Sverdlovsk region cities based on the SI parameter values in 2011–2015

0–1 – low level of pollution

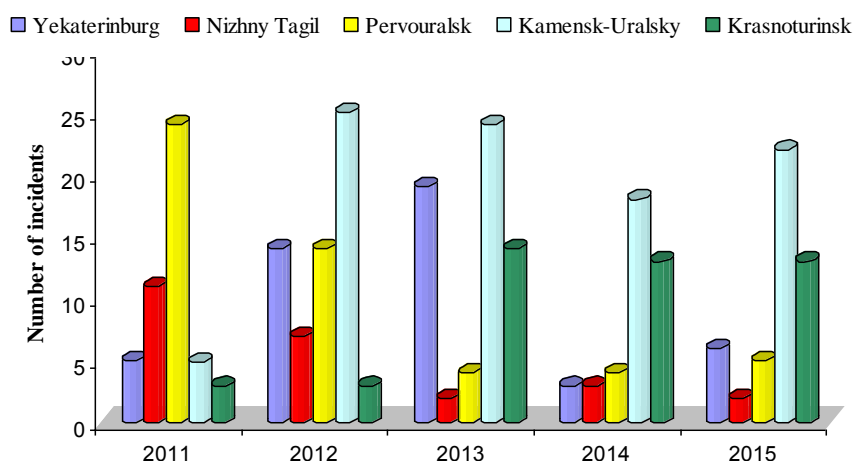
2–4 – increased level of pollution

5–10 – high level of pollution

11 and above – very high level of pollution

As we can see from the diagram the SI values were elevated and were determined by the maximum monthly average concentrations of benzopyrene in Pervouralsk and Krasnoturinsk. The SI values were determined by maximum single concentrations of solid fluorides in Kamensk-Uralsky.

The values of the highest repeatability of exceeding TLV (HR parameter) were elevated in all Sverdlovsk region cities in 2011–2015. The exception was Kamensk-Uralsky, where the HR level remained at a high level. In 2015, the HR values were determined by the highest repeatability of TLV excesses, for example suspended substances in Yekaterinburg, hydrogen fluoride in Krasnoturinsk and Pervouralsk, solid fluorides in Kamensk-Uralsky, and formaldehyde in Nizhny Tagil (Figure 4).



**Figure 4.** The atmospheric air quality in the Sverdlovsk region cities of the based on the HR parameter values in 2011-2015 (excluding data on benzopyrene)

0 – low level of pollution

1–19 – increased level of pollution

20–49 – high level of pollution

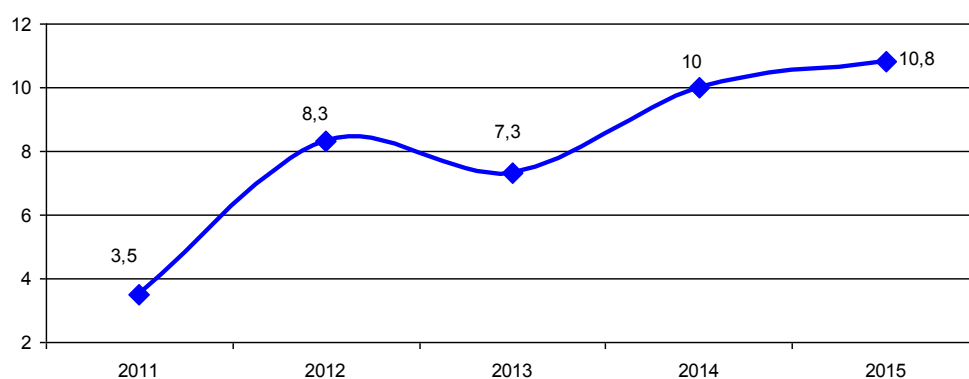
50 and above – very high level of pollution

### 3.2. Estimation of atmospheric air

This article represents the study results of the gaseous emissions dynamics of the chemical complex enterprises in the Sverdlovsk Region for the period from 2011 to 2015 [12, 13].

In 2015 year, in compare to 2014, emissions of pollutants into atmospheric air from stationary sources were decreased by 37.3 thousand tons (by 3.7 %). Decrease in the total amount of emissions into atmospheric air was mainly in communication with the reduction of electricity generation, fuel consumption, a decrease in production at a number of enterprises, a reduction in the volume of repair work, and the implementation of environmental measures. Pollutants emissions into the air in the region were decreased by 119.2 thousand tons (by 10.8 %) in compare to 2011.

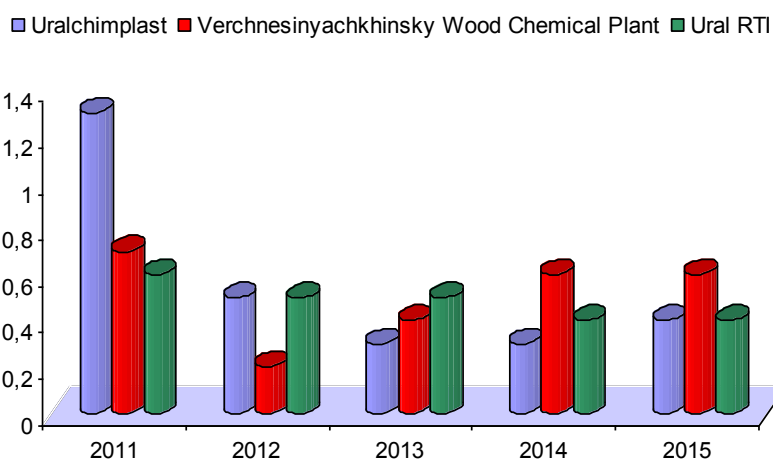
Volumes of pollutants emissions into the air from chemical industries, industries of rubber and plastic products, by types of economic activity are shown at figure 5 during the period 2011–2015.



**Figure 5.** Harmful (polluting) substances emissions volumes into atmospheric air from chemical industries, thousand tons

The contribution of emissions from chemical industry is relatively low and accounts for approximately 4 % of emissions from all manufacturing industries, including metallurgical complexes.

In the Sverdlovsk region, the largest chemical enterprises are Uralchimplast, Uralplastic, Ural RTI, Ural Tire Plant and Verkhnesinyachikhinsky Wood Chemical Plant which are the main sources of atmospheric air pollution to total emissions of pollutants into the atmosphere from stationary sources in the Sverdlovsk region. Assessment of their contribution was carried out on the basis of information provided by these enterprises and is shown in figure 6 for the period 2011–2015.

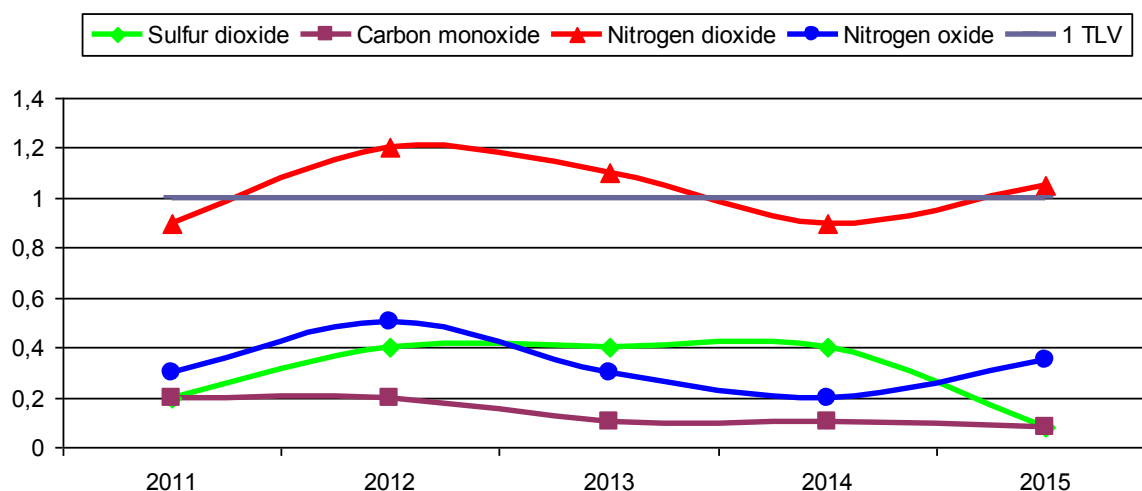


**Figure 6.** Dynamics of changes in emissions of pollutants into the atmosphere from major chemical enterprises, thousand tons

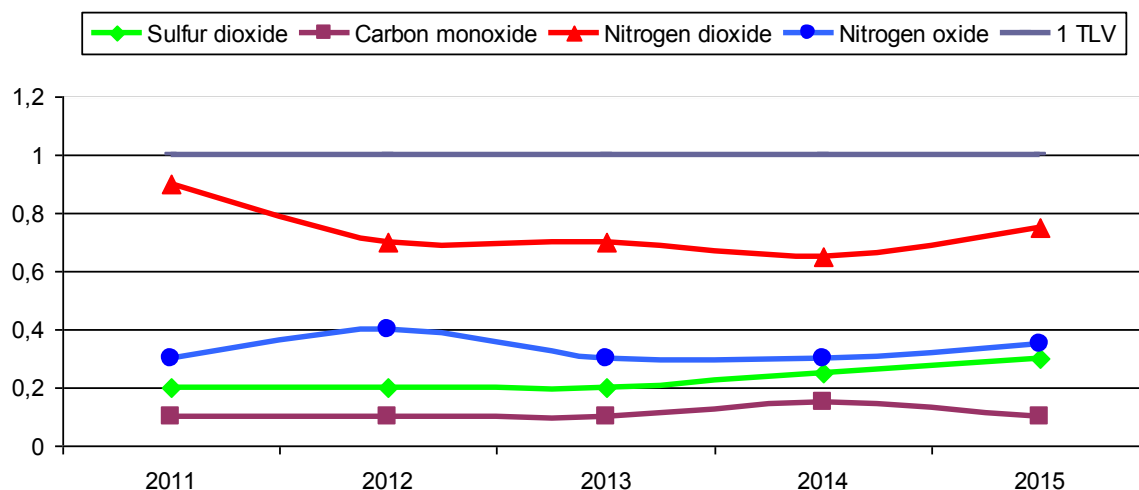
As we can see from the diagram there is a general tendency to reduce emissions of pollutants in connection with the implementation of environmental measures. However, in 2015 Uralchimplast have increased the amount of emissions by 0.1 thousand tons (by 33.3 %), which was associated with an increase in output.

### 3.3. Influence of chemical enterprises on atmospheric air

In addition, we have analyzed the dynamics of changes in the atmospheric air state in cities where the big chemical enterprises are located (figures 7–9). The main air pollutants which enterprises emit into the atmosphere are sulfur dioxide, carbon monoxide and nitrogen oxides.



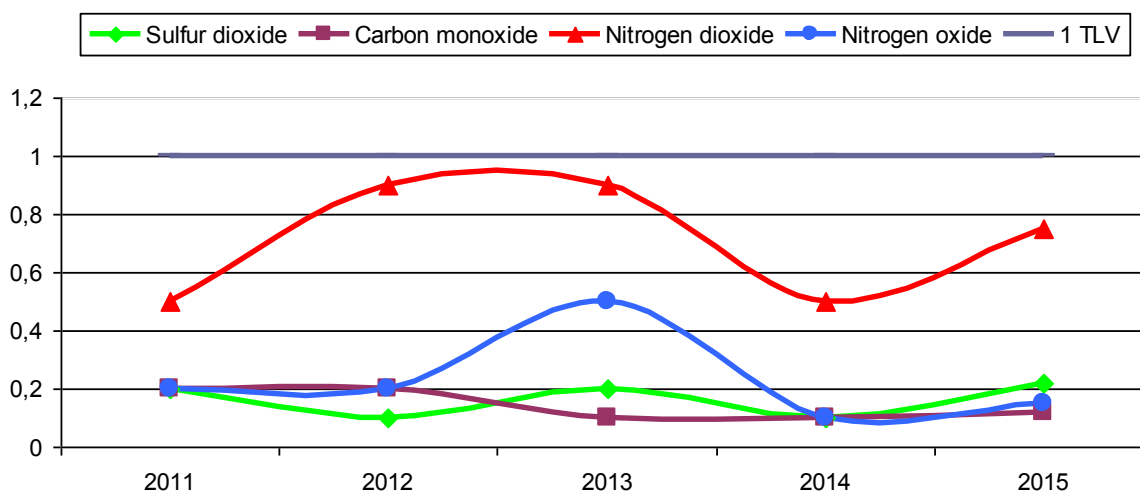
**Figure 7.** Average annual pollutant concentrations in the atmospheric air of Yekaterinburg in 2011–2015



**Figure 8.** Average annual pollutant concentrations in the atmospheric air of Nizhny Tagil in 2011–2015

We found that there is a general tendency to reduce gaseous polluting emissions of  $\text{SO}_2$ ,  $\text{CO}$ ,  $\text{NO}_2$  and  $\text{NO}$  in all cities with the big chemical enterprises. It should be noted that the dynamics of pollutant emissions into the atmosphere from stationary sources have an oscillatory nature. Probably, this is due to the unsustainable activity of enterprises in a market economy (alternation of recessions and upsurge in production, changes in the nomenclature of produced products, the output volume and the used raw materials quality). Reducing the gaseous substances emission can be achieved both by improving

the production technology, and by installing new more sophisticated equipment which catches harmful substances emissions.



**Figure 9.** Average annual pollutant concentrations in the atmospheric air of Kamensk-Uralsky in 2011–2015

#### 4. Conclusion

To sum up, it should be noted that the total pollutant emissions into the air environment by chemical enterprises are decreasing in the Sverdlovsk region. However, only 20 % pollutant emission reductions ( $\text{SO}_2$ , CO,  $\text{NO}_2$  and NO) are associated with measures which reduce anthropogenic impact on the environment. The main reason (about 50 %) is the decline in production due to the unstable economic situation.

The total amount of purified emissions is increased due to scientific and technological development and improvement of modern industry. For example, Uralchimplast invests in modernizing its production facilities, carries out work on reduction all types industrial waste [14]. Uralchimplast operates an independent Eco-Service that is accredited up technical competence in the field of eco-analytical control and registered in the State Register of the Russian Federation. At this enterprise there are 40 dust and gas cleaning installations, thus, emissions do not exceed the established maximum permissible norms of emissions for all ingredients.

This has a favorable effect on the environmental situation in the Urals region, and in particular in the Sverdlovsk region.

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